

DEPARTMENT OF ENERGY
IDAHO FIELD OFFICE
LEAD AGENCY ACTION MEMORANDUM REMOVAL ACTION
TEST AREA NORTH (TAN)
TAN SUPPORT FACILITY (TSF)-38 BOTTLE SITE

07/15/94

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**DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
LEAD AGENCY ACTION MEMORANDUM REMOVAL ACTION
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SUBJECT: Action memorandum for a time-critical removal action at Waste Area Group (WAG) 1 Operable Unit (OU) 1-03, Technical Support Facility (TSF)-38 Bottle Site, Idaho National Engineering Laboratory, Butte County, Idaho.

I. PURPOSE:

The purpose of this time-critical removal action is to:

- Substantiate the need for a removal response
- Identify the proposed action
- Describe the rationale for the proposed action.

II. SITE CONDITIONS AND BACKGROUND

The Technical Support Facility (TSF)-38 is the site of the Test Area North (TAN) Laboratory Container Disposal Area, a soil plot defined by a 12.2 x 18.3 m (40 x 60 ft) rectangular area located approximately 91 m (300 ft) east of the TAN gravel pit. Within this plot are two earth mounds approximately 0.3 m (1 ft) tall, 1.4 m (4.5 ft) wide, and 14 m (45 ft) long. Both are oriented north-south. Employee interviews have determined that the site was used in the 1950s as a burn pit.

In March 1992, approximately 15 1-L amber laboratory reagent bottles and five rusted ether cans were discovered on the surface of a 1.4 x 1.8 m (4.5 x 6 ft) area located approximately 0.6 m (2 ft) west of the western-most mound. Further employee interviews determined that approximately 400 to 500 containers of excess laboratory waste may have been disposed at the site. Some or all of the waste may have originated in 1961 when Phillips assumed responsibility of the General Electric (GE) metallurgical laboratory at TAN 607 building. The extent of subsurface contamination remains unknown.

A. SITE DESCRIPTION

1. REMOVAL SITE EVALUATION

The surface contamination was remediated as part of a cleanup effort by DOE in March 1992. This effort was separate from the Federal Facilities Agreement and Consent Order (FFA/CO) and was managed by the Site Remediation Unit, WAG 1. Bottles, bottle fragments, ether cans, stained soil, and other surface debris were removed from the site and analyzed for radioactive, organic, and explosive parameters using field instruments and a portable gas chromatograph. No contamination was detected. One of the surface bottles contained asbestos. A second bottle contained a barium compound. The other bottles located on the surface and all of the soil was determined to be nonhazardous.

This site's key problem area consists of the unknown subsurface contamination of the 1.4 x 1.8 m (4.5 ft x 6 ft) area that was previously littered with laboratory containers.

2. PHYSICAL LOCATION

TAN was built between 1954 and 1961 to support the Aircraft Nuclear Propulsion Program sponsored by the US Air Force and the Atomic Energy Commission. Except for the Specific Manufacturing Capability Facility which is operated by Babcock and Wilcox, TAN is now operated under DOE contract by EG&G Idaho, Inc.

TAN is the northernmost facility within the Idaho National Engineering Laboratory (INEL) and consists of several experimental and support facilities for conducting research and development activities on reactor performance (Figures 1 and 2). The TAN complex is located approximately 80 km (50 mi) northwest of Idaho Falls, Idaho, and 24 km (15 mi) west of the Terreton, Idaho. The major facilities at TAN include the Technical Support Facility (TSF), Containment Test Facility (CTF), Specific Manufacturing Capability (SMC), Water Reactor Research Test Facility (WRRTF), and the Initial Engine Test (IET) Facility.

3. SITE CHARACTERISTICS

During the March 1992 remediation of the surface materials and excavation of the stained soils, five additional bottles were found

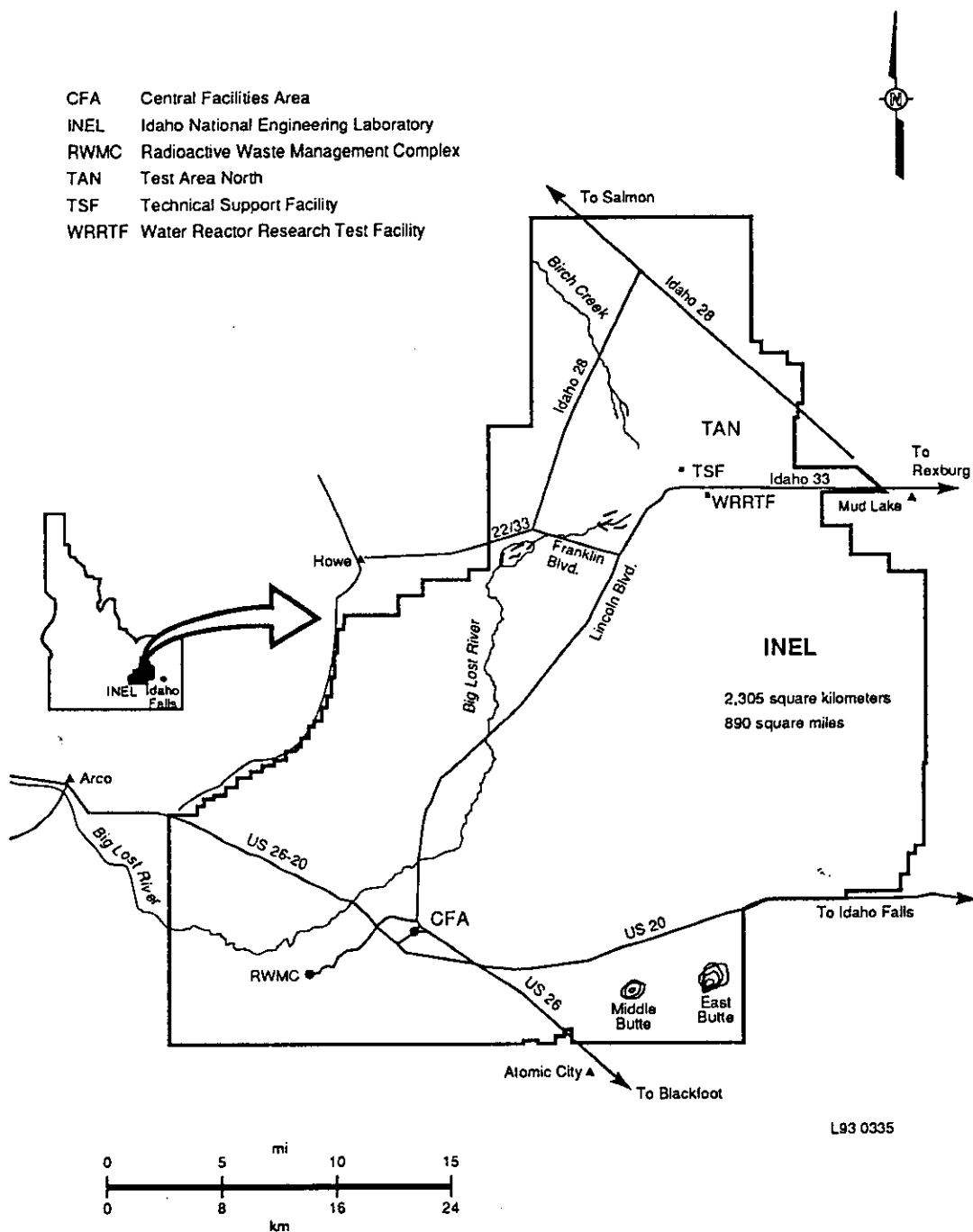


Figure 1. Location of TAN at the Idaho National Engineering Laboratory.

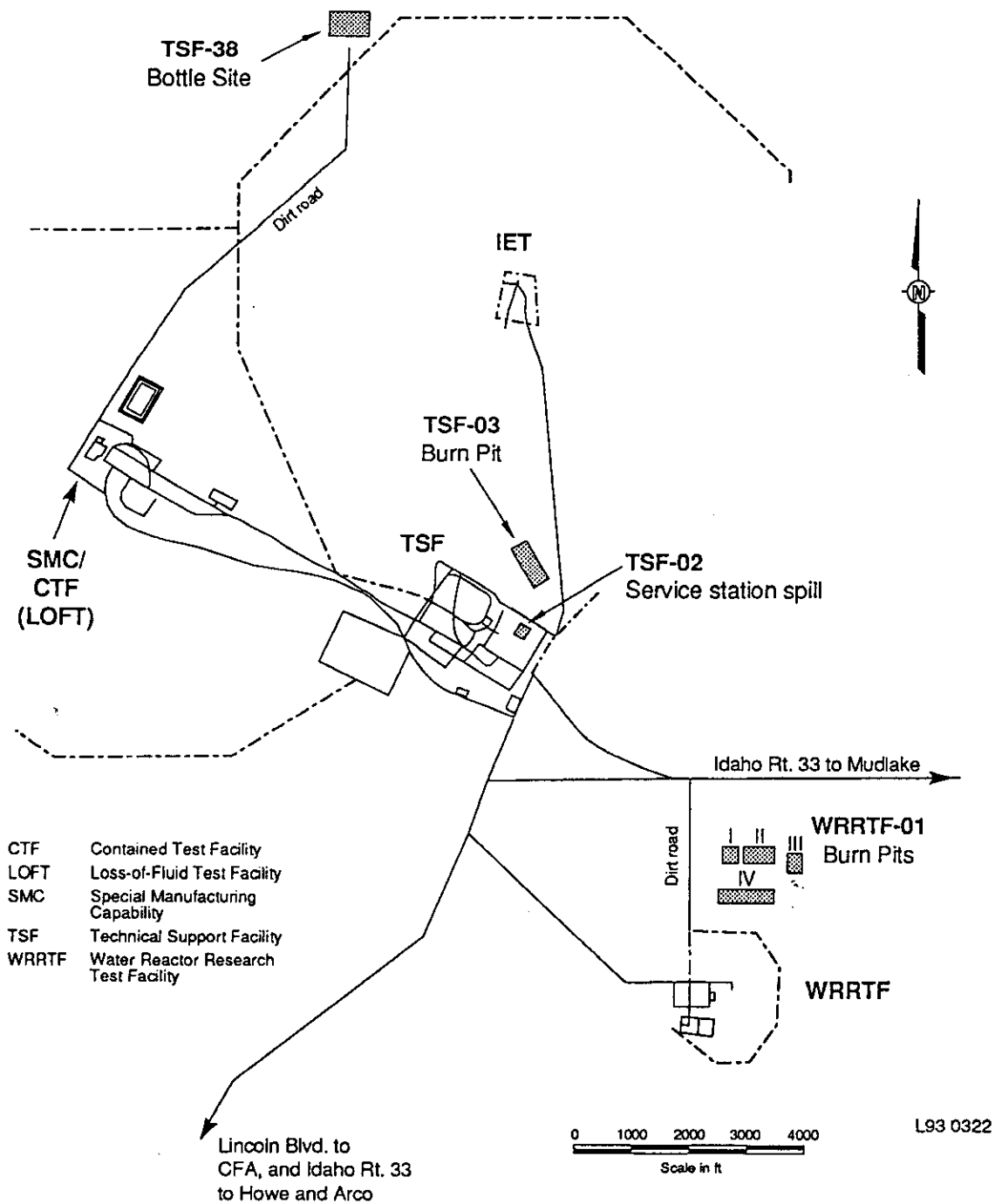


Figure 2. Location map of TSF-38 Bottle Site in Relation to OU 1-03 Subunits: TSF-03, WRRTF-01 Burn Pits, and TSF-02 Service Station Spill.

buried 7.6 to 15.2 cm (3 to 6 in.) below grade and two more bottles were found approximately 20.3 cm (8 in.) below grade. The soil surrounding these bottles was stained yellow-green. No explosive, radioactive, or organic compounds were found in the soil or bottles. However, laboratory analysis indicated that the stained soil contained high levels of molybdenum, lead, and cadmium. The first five bottles were removed from the site, leaving the other two. The remaining bottles were covered with a plastic sheet and the excavated hole was backfilled with soil. The site is fenced, the excavation is covered with a plastic tarp, and the TSF-38 area is roped off and posted to prevent site access.

The general physical properties of the TAN area include:

- Most of the soils in the TAN area are of the Terretton soil series, although there are some Zwiefel series in areas where sand has collected. Surface soils at TAN have high water-holding capacity because of their texture, but are nearly impermeable because of smooth, sealed surfaces that favor runoff.
- The 30-year normalized average daily air temperature at TAN ranges from a low of 10.5°C(44°F) during mid-January to a high of 21°C(87°F) in late July. The average annual precipitation at TAN was 19.9 cm (7.83 in.) between 1950 and 1964. The monthly averages for the same period show a pronounced peak in May and June, with 3.48 and 3.02 cm (1.37 and 1.19 in.) respectively. Wind at the INEL, as indicated by the Central Facilities Area (CFA) weather station, typically blows from the southwest, moving up the Eastern Snake River Plain (ESRP). This is because regional prevailing west winds are channeled along the axis of the ESRP by the mountains bordering the plain. Winds from the northeast are also common, especially at night when the daytime flows are reversed by cool air moving back down the plain. Wind directions at TAN are modified somewhat by the proximity of the TAN complex to the broad, northwest-trending Birch Creek Valley. This causes the normal southwesterly flow to be directed to a south-southwesterly flow and produces a strong component of wind from the north-northwest down the Birch Creek Valley. Reverse flows are from a northerly to north-northeasterly direction.

- For more detail concerning the physical properties of TAN, refer to the *Remedial Investigation Final Report with Addenda for the Test Area North Groundwater Operable Unit 1-07B at the Idaho National Engineering Laboratory, Volume 1*, (EGG-ER-10643).

As the March 1992 remediation activity was not part of the FFA/CO process, this is the first removal action at this site.

TAN is part of the INEL, a federally owned facility operated by the Department of Energy (DOE).

4. **RELEASE OR THREATENED RELEASE INTO THE ENVIRONMENT OF A HAZARDOUS SUBSTANCE, POLLUTANT, OR CONTAMINANT.**

The type of subsurface contamination, as well as the quantity, is unknown at this time, but based on the characteristics of the material removed in the earlier remediation activities, there may be potential for release or threatened release of hazardous substance, pollutants, or contaminants into the environment. Characterization of the waste material removed is summarized in letters from M. C. Verwolf to Jerry Zimmerle, MCV-02-92 and MCV-03-92, dated March 30 and April 1, 1992 (see Attachment 1). Using this information, risk-based soil screening concentrations were calculated using methodology presented in the Track 1 guidance manual.

Because the amounts of cadmium, chromium, and molybdenum were higher than risk-based soil screening concentrations, DOE Idaho Operations Office (DOE-ID) requested an additional risk evaluation for the two mounds at the site. [See attached letter, December 13, 1993, from Shannon M. Rood to Jerry R. Zimmerle, SMR-32-93 (Attachment 2)]. Two scenarios were used: (a) an occupational worker exposed to the site for 25 years in the current time frame, and (b) a resident who moves to the site 30 years in the future and digs a 3-m (10-ft basement).

The total risk for the occupational scenario is 3×10^{-5} and represents the potential incremental risk posed by ingesting soil contaminated with beryllium. The second largest risk driver is chromium-6 (9×10^{-8}) for the inhalation pathway. The total hazard quotient (HQ) for noncarcinogenic effects is 5×10^2 . For the soil ingestion pathway, mercury has the largest hazard quotient (5×10^2). The next largest HQ is for soil ingestion of cadmium (1×10^{-1}). The next largest risk

drivers for the occupational scenario are below levels that indicate a potential adverse health effect.

The total risk for the residential scenario is 3×10^{-4} and represents the potential incremental risk posed by ingesting soil contaminated with beryllium. The second largest risk driver is chromium-6 (3×10^{-8}) for the inhalation pathway. The total HQ for noncarcinogenic effects is 4×10^3 , which constitutes the hazard quotient for ingestion of soil contaminated with mercury. The next largest HQ is for soil ingestion of cadmium (8×10^{-1}). The next largest risk drivers for the occupational scenario are below levels that indicate a potential adverse health effect.

5. NATIONAL PRIORITIES LIST (NPL) STATUS

TAN, designated as WAG 1, is located within the boundaries of the designated INEL NPL site. After listing the INEL on the NPL, DOE, the Environmental Protection Agency (EPA) and the Idaho Department of Health and Welfare's Division of Environmental Quality (IDHW-DEQ) signed the Federal Facilities Agreement and Consent Order (FFA/CO) on December 4, 1991. It was determined by DOE, EPA, and IDHW during the initial scoping discussions that additional data collection was not necessary. This decision, documented in the OU 1-03 Track 2 Statement of Work (SOW), was based on an assumption that the site was limited to a small number of laboratory bottles and stained soil on the ground surface. It was believed that potential risks associated with the site could be adequately addressed by a cleanup action that was in progress as the sampling plan was being developed. However, as the cleanup action progressed, it became evident that the size of the site was greater than expected and potential risks at the site would only be partially addressed by the cleanup. Because the immediate risk was removed by the surface cleanup action, it was decided to place TSF-38 into the OU 1-10 remedial investigation/feasibility study (RI/FS) so that additional data collection and risk assessment could be done, and remedial alternatives could be developed.

As funding is now available, all three agencies have agreed to expedite the cleanup.

6. LOCATION MAPS

Figure 1 (page 3) shows the location of TAN in relation to the Idaho National Engineering Laboratory (INEL). Figure 2 (page 4)

shows the location of TSF-38 in relation to the other OU 1-03 Subunits.

7. OTHER ACTIONS TO DATE

The surface area of this site was remediated as part of a DOE cleanup effort in March 1992, separate from the FFA/CO. No action to date has been initiated to the subsurface, the area of concern of the removal action.

8. STATE AND LOCAL AUTHORITIES' ROLES

The IDHW-DEQ and EPA have reviewed and commented on this removal action memorandum. Results of this removal action will be reviewed in accordance with the FFA/CO. This action will comply with federal and state applicable or relevant and appropriate requirements (ARARs).

III. THREATS TO PUBLIC HEALTH, WELFARE, OR THE ENVIRONMENT; STATUTORY AND REGULATORY AUTHORITIES

The unknown conditions that exist at the site, which, if not addressed by implementing the response action plan, may present a continued undetermined endangerment to the environment. Conditions at the site meet the criteria for a removal action as stated in the National Contingency Plan (NCP).

A. Threats to the Environment

Threats to the environment, as described in the NCP, 40 Code of Federal Regulations (CFR) Section 300.415(b)(2), are as follows:

1. (i): *Actual or potential exposure to nearby human population, animals, or the food chain from hazardous substances or pollutants or contaminants.*

A Track 2-type risk evaluation indicates a possible potential for exposure to nearby human population, animals, or the food chain.

2. (ii): *Actual or potential contamination of drinking water supplies or sensitive ecosystems.*

A Track 2-type risk evaluation indicates there may be a potential for drinking water contamination.

3. (iii): *Hazardous substances or pollutants or contaminants in drums, barrels, tanks or other bulk storage containers, that may pose a threat of release.*

The waste is not containerized for bulk storage.

4. (iv): *High levels of hazardous substances or pollutants or contaminants in soil largely at or near the surface, that may migrate.*

Levels of contamination are unknown, although are not expected to be high, based on previous removal of surface material.

5. (v): *Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released. Precipitation may cause further release and migration of the waste.*

The site is in the Birch Creek Playa system.

6. (vi): *Threat of fire or explosion.*

Identity of remaining material is unknown; however, based on sampling activities during surface removal action, no threat of fire or explosion exists.

7. (vii): *The availability of other appropriate federal or state response mechanisms to respond to the release:*

Resources for other federal or state mechanisms to respond to the release are limited.

8. (viii): *Other situations or factors that may pose threats to public health or welfare or the environment.*

There is potential for exposure of human and animal receptors as material is unknown. Action needs to be taken to remove the threat of a future release to the environment of these potentially hazardous wastes.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, welfare, or the environment.

V. PROPOSED ACTIONS AND ESTIMATED COSTS

The alternatives considered for this site were:

Option 1. No action

Option 2. Cap with a 6 in. dirt cover.

Option 3. A time-critical removal action under CERCLA authority.

Option 3 is preferred over Option 1 and 2 because it prevents migration of the waste to the environment by removing the waste source.

Option 3 is also preferred over Option 2 because the waste will be handled under CERCLA authority, which will ensure that all substantive requirements of the State Hazardous Waste Management Act (HWMA) are met without the administrative burden associated with full compliance.

A. Scope of Work

The proposed action includes subcontracting a turnkey operation to: (a) excavate a maximum of 1.2 m (4 ft) of soil in a 4.6 x 4.6 m (15 x 15 ft) area from the TSF-38 Bottle Site; (b) separate broken bottles and intact bottles from the removed soil; (c) sample and characterize the liquids contained in the intact bottles, as well as the broken bottles and the soil for determination of proper waste disposal locations; (d) package and ship material to appropriate locations for treatment and/or disposal; (e) restore the excavated area with clean soil and reseed the area with a native species; (f) Excavate up to four exploratory trenches into each mound and between each mound to determine contents; and (g) restore the area with excavated material..

B. Storage and Labeling of CERCLA Waste

The waste material removed from the bottle site will be CERCLA removal action waste and will be placed into containers (208-L, or

55-gal drums) before being disposed. The containers will meet the use and management standards applicable to containers listed in Subpart 1 of 40 CFR 265. These standards generally regulate the condition and compatibility of containers with waste materials and the management and inspection of the container. The containers will be inspected weekly while the waste is awaiting shipment for disposal. The containers will be labeled as CERCLA waste. Additional labeling will include radiological activity and radiation field measurements as appropriate.

The containers will be placed in a locked or controlled area, or equivalent, pending waste treatment. These containers will be a CERCLA Storage Unit (CSU) with appropriate labeling. Emergency and contingency procedures will be addressed in the Removal Action Project (RAP) plan for this activity. These procedures will address spill prevention and spill response actions and will include emergency coordinators and telephone contacts. These procedures will meet the requirement of 40 CFR 265 Subpart D (Contingency Plan and Emergency Procedures) considering the exigencies of the situation.

C. Proposed Action

1. Contribution to Remedial Performance

This removal action would contribute to the efficient performance of future action under the FFA/CO by removing possibly hazardous waste from OU 1-10.

2. Description of Alternative Technologies

Other than no action and capping, which are both land disposal technologies, no alternatives to land disposal technologies have been considered because this site consists of small quantities of unknown material.

3. Engineering Evaluation/Cost Analysis

This applies only to non-time-critical responses. This response is a time-critical removal action.

4. Applicable or Relevant and Appropriate Requirements (only the substantive portions of the following regulations are ARARs).

Federal ARARs

40 CFR Part 261: "Identification and Listing of Hazardous Waste"

Subpart A—General

261.1 Purpose and Scope

261.2 Definition of Solid Waste

261.3 Definition of Hazardous Waste

Subpart B—Criteria for Identifying the Characteristics of Hazardous Waste and for Listing Hazardous Waste

Subpart C—Characteristics of Hazardous Waste

40 CFR Part 262: "Standards Applicable to Generators of Hazardous Waste"

Subpart A—General

Subpart B—The Manifest

Subpart C—Pre-Transport Requirements

40 CFR Part 265: "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"

Subpart D—Contingency Plan and Emergency Procedures

40 CFR Part 268: "Land Disposal Restrictions"

Subpart A—General

268.3 Dilution Prohibited as a Substitute for Treatment

268.7 Waste Analysis and Record keeping

268.9 Special Rules Regarding Wastes that Exhibit a Characteristic

Subpart D—Treatment Standards

Subpart I—Use and Management of Containers

State ARARs

IDAPA 16.01.05008 "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"

IDAPA 16.01.05011 "Land Disposal Restrictions"

5. Project Schedule

Planning for this response action is under way; it is expected that field activities will begin in July and be completed by September 30, 1994.

D. Estimated Costs

The estimated costs to perform the three options are:

Option 1--No Action	\$30,000
Option 2--Cap	\$130,000
Option 3--Removal	\$531,405.

The scope of Option 1, No Action, includes monitoring the area for 50 years. The scope of Option 2, Cap, includes installation of a fabric membrane cap and also includes the monitoring of Option 1. This cost could vary from \$25,000 to \$100,000 depending on the type and size of cap required. The Scope of Option 3, Remediation, includes planning activities, subcontract management, site remediation, disposal of the waste, IDHW-DEQ/EPA coordination, and public notification. Option 3 also includes RCRA permitting activities.

VI. EXPECTED CHANGE IN SITUATION IF ACTION IS DELAYED OR NOT TAKEN

If delayed, cleanup at TSF 38 would probably be accomplished as an FFA/CO Interim Action at the conclusion of the OU 1-10 Remedial Investigation/Feasibility Study (RI/FS) scheduled in 1995. If the removal action is delayed, the cost of future cleanup as an interim action would increase, assuming normal inflation and higher costs associated with an interim action. If the removal action is not performed, the risk of release of hazardous substances to the environment would be increased.

VII. OUTSTANDING POLICY ISSUES

No outstanding policy issues are associated with this action.

VIII. ENFORCEMENT

DOE-ID will conducting this removal action as the lead agency under the

authority of 40 CFR 300.5 and 300.415 (b)(1).

IX. RECOMMENDATION

This decision document represents the selected removal action for the OU 1-03, TSF-38 Bottle Site, in Butte County, Idaho, and was developed in accordance with CERCLA as amended and is not inconsistent with the NCP. Conditions at this site meet the NCP Section 300.415(b)(2) criteria for a removal. This action was approved by DOE-ID on March 28, 1994, at a Baseline Change Proposal meeting (see attached approved Baseline Change Proposal EB-94-38).

Total project costs are estimated at \$531,405. Funding for this project is being provided by DOE-ID.

ATTACHMENT 1

INTEROFFICE CORRESPONDENCE

Date: March 30, 1992
To: Jerry Zimmerle, MS 1545
From: M. C. Verwolf, MS 4107 *MC Verwolf*
Subject: TAN BOTTLE SITE SAMPLES RECEIVED 3/12/92 - MCV-02-92

Twelve unknown samples from the Tan Bottle Site were received by ECU on March 12, 1992, for qualitative identification. Results of the tests performed are provided in attached tables 1 through 5.

The physical appearance of the samples are described in Table 1.

Qualitative Analyses of Samples

Solubility Testing for Qualitative Identification of red powder present in 92072003 and 92072012:

The physical appearance of the samples and cross-reference of lab and field sample identification is given in Table 1. The red powder from samples 92072003 and 97072012 was selectively subsampled and tested for solubility in water, 50% Nitric Acid, hydrochloric acid, hexane and methanol. Two control samples with no visible red powder were also tested. Results of the solubility tests are provided in Table 2.

Initial qualitative scans of the 50% nitric acid solutions were performed by ICP-MS. Iron levels were elevated as much as ten times for samples 92072003 and 97020012 compared to the other two control samples. The red powder was suspected to be Fe_2O_3 , which is soluble in hydrochloric acid. As a check, hydrochloric acid was added to reagent grade Fe_2O_3 ; the acid solution turned yellow as the ferric oxide dissolved. This behavior, identical to that of samples 92072003 and 92072012, supports the supposition that the red powder may be ferric oxide.

Carbonate and Hydrogen Sulfide Qualitative Analyses:

Samples were put into test tubes, acid was added, and the gas formed was bubbled through a solution of $\text{Ba}(\text{OH})_2$. Precipitation of BaCO_3 in the $\text{Ba}(\text{OH})_2$ solution indicates that carbonates are present in the original samples.

X

The twelve samples had substantial effervescence occur when acid was added to the samples. A carbonate precipitate formed in the barium hydroxide solution when all samples were tested. Additionally, the samples produced noticeable hydrogen sulfide odor after acidification. From these tests we conclude that all samples contain a bicarbonate/carbonate species and sulfide species. The presence of sulfide in the samples is likely due to the reduction of sulfates present in the samples.

Semi-Quantitative Analyses

Water Soluble Anions Determined by Ion Chromatography

One gram of each sample was leached with 10 mL of water for ten minutes and semi-quantitated for water-soluble anions by Ion Chromatography, using a one point calibration. These results are shown in Table 3.

Nitrate is present at the highest concentration in the samples, and shows the greatest variation in concentration between samples. Fluoride, chloride, phosphate, and sulfate concentrations vary by smaller amounts between samples. Bromide and nitrate were not detected above 2.0 mg/kg in any of the samples.

Semi-Quantitative Analyses for Metals by ICP-MS

Approximately one gram of each sample was leached by adding 5 mL of water and 10 mL each of nitric acid and hydrochloric acid. The samples were heated to 95 C for approximately two hours, allowed to cool, and diluted with water to a final volume of 200 mL. A dilution of the leachate was analyzed by ICP-MS in semi-quantitative mode.

Table 4 presents semi-quantitative results for transition and toxic metals found above 10 ppb in the leachates. Silver and mercury, with detection limits similar to the metals in Table 4, were not detected in any of the samples. Arsenic and selenium are not reported from the ICP-MS analyses, due to interferences with the analyses. Visual examination of the spectra does not indicate elevated levels of these analytes. Samples 92072003 and 92072012 have significantly higher levels of iron present than the other ten samples, supporting the conclusion that the red powder in them is ferric oxide.

Table 5 shows recoveries for a semi-quantitative standard analyzed with the samples. Recoveries of this standard indicate the degree of accuracy associated with the semi-quantitative data. Calcium and iron, present in the standard at 50 µg/L, were not detected at this lower level, but were easily detected at the higher levels present in the samples.

J. R. Zimmerle
March 30, 1992
MCV-02-92
Page 3

Please contact me or Shelly Sailer at 6-2730 if you have questions concerning these data.

mcv/sjs

Attachments:
As Stated (5)

cc: J. T. Bennett, MS 4107 *JB*
R. C. Green, MS 4129
S. J. Sailer, MS 4107 *SS*
Project File - Report Group 920017-A
Central Files - MS 1651
M. C. Verwolf File

Table 1: Physical Descriptions of Samples from Tan Bottle Site

<u>Lab Sample ID</u>	<u>Customer ID</u>	<u>Sample Description</u>
92072001	TANBOT92009	Light brown soil with vegetation
92072002	TANBOT92010	Light brown soil with vegetation
92072003	TANBOT92011	Brown soil with red powder present
92072004	TANBOT92012	Light brown, fine soil
92072005	TANBOT92013	Light brown, fine soil
92072006	TANBOT92014	Light brown, fine soil
92072007	TANBOT92015	Light brown soil
92072008	TANBOT92016	Light brown soil with vegetation
92072009	TANBOT92017	Medium brown, damp soil
92072010	TANBOT92018	Medium brown, damp soil
92072011	TANBOT92019	Medium brown, damp soil
92072012	TANBOT92020	Medium brown soil with red lumps of powder

Table 2: Results of Solubility Tests

<u>Sample ID</u>	<u>Solvent</u>	<u>Observations</u>
92072002 (control)	Water	No apparent dissolution.
	50 % Nitric	Initial effervescence occurred but no dissolution.
	HCl	Initial effervescence occurred but no dissolution.
	Hexane Methanol	No dissolution or reaction. No dissolution or reaction.
92072003	Water	Red color dispersed through liquid in fine suspension, but not dissolution.
	50% Nitric	Initial effervescence occurred with addition of acid, fine suspension of red powder.
	HCl	Red powder dissolved in acid, turning solution yellow.
	Hexane Methanol	No dissolution or reaction. No dissolution or reaction.
92072004 (control)	Water	No apparent dissolution.
	50 % Nitric	Initial effervescence occurred, but no dissolution.
	HCl	Initial effervescence occurred, but no dissolution.
	Hexane Methanol	No dissolution or reaction. No dissolution or reaction.
92072012	Water	Red color dispersed through liquid in fine suspension, but not dissolution.
	50% Nitric	Initial effervescence occurred with addition of acid, fine suspension of red powder.
	HCl	Red powder dissolved in acid, turning solution yellow.
	Hexane Methanol.	No reaction or dissolution. No reaction or dissolution.
Fe ₂ O ₃ Reagent	HCl	Red powder dissolved in acid, turning solution yellow.

Table 3: Semi-quantitative Results for Water Soluble Anions Determined by Ion Chromatography

Sample ID	-----mg/kg wet weight-----				
	<u>Fluoride</u>	<u>Chloride</u>	<u>Nitrate</u>	<u>Phosphate</u>	<u>Sulfate</u>
92072001	4.0	2.6	27	9.1	4.0
92072002	3.5	4.0	40	9.1	3.7
92072003	2.2	2.9	28	4.8	3.7
92072004	3.2	8.3	81	8.4	5.0
92072005	4.9	2.5	10	4.6	6.4
92072006	4.2	4.8	12	7.1	10
97072007	2.6	3.8	47	6.0	9.2
97072008	6.0	7.2	41	<2.0	4.3
97072009	4.2	5.0	34	8.3	6.7
97072010	7.4	8.2	57	<2.0	11
97072011	4.9	6.6	48	16	4.1
97072012	3.3	3.0	52	<2.0	12

Table 4: Results of ICP-MS Semi-quantitative Analyses, p. 1

Report Group No. 9200017

Date Samples Received: 3/12/92

Date Samples Digested: 3/13/92

Date Samples Analyzed: 3/16/92

Lab Sample Id.	Result mg/kg wet weight basis						
	Magnesium	Aluminum	Calcium	Vanadium	Chromium	Manganese	Nickel
92072001	8892	4190	117536	44	28	158	8350 5.1
92072002	10326	7332	103468	88	187	275	14200 27
92072003	9782	5341	130404	82	36	312	173500 21
92072003 Dup.	9309	4468	122874	50	22	304	158600 11
92072004	10953	5250	571006	75	22	218	11500 <2.1
92072005	10128	4646	120792	37	20	166	10200 <2.4
92072006	12083	6703	143507	57	25	224	14500 5.7
92072007	8080	4032	108430	20	12	138	7360 13
92072008	9403	5181	140807	34	22	179	10700 <1.8
92072009	12826	7887	138054	44	29	244	15900 5.5
92072010	13171	6932	159938	42	24	222	12600 37
92072011	9651	6152	119219	54	30	193	11900 12.5
92072012	12571	7880	139763	26.5	138	302	62950 45
Preparation Blank	<2.0	241	<2.0	21	<2.0	<2.0	<2.0

Table 5: Recoveries of ICP-MS Semi-quantitative Standard.

		True Value ug/L	Inst Reading ug/L	Recovery SemiQuant
		=====	=====	=====
ICP-MS Std	Li	50	86.108	173
	Be	100	50.854	51
	Mg	100	74.155	74
	Al	50	43.429	87
	Ca	50	Not Found	Not Found
	Sc	Not Present		
	V	50	61.349	123
	Cr	50	59.153	118
	Mn	50	64.96	130
	Fe	50	Not Found	Not Found
	Co	100	97.032	97
	Ni	100	77.708	78
	Cu	50	60.053	120
	Zn	50	30.874	62
	As	50	9.864	20
	Se	50	4.6	9
	Rb	50	42.731	85
	Sr	50	47.802	96
	Y	Not Present		
	Zr	Not Present		
	Mo	Not Present		
	Cd	50	37.499	75
	Ba	50	60.421	121
	La	Not Present		
	Ce	50	64.161	128
	Pr	Not Present		
	Nd	Not Present		
	Sm	Not Present		
	Yb	Not Present		
	Ir	Not Present		
	Hg	Not Present		
	Pb	100	92.032	92
	Bi	100	82.247	82
	Th	Not Present		
ICP-MS Std.	U	100	88.662	88.66

INTEROFFICE CORRESPONDENCE

Date: April 1, 1992
To: Jerry Zimmerle, MS 1545
From: M. C. Verwolf, MS 4107 *MC Verwolf*
Subject: TAN BOTTLE SITE SAMPLES RECEIVED 3/17/92 - MCV-03-92

Four unknown samples from the TAN Bottle Site were received by ECU on March 17, 1992, for qualitative identification. Results of the tests performed are provided in attached tables 1 through 5.

The physical appearance of the samples are described in Table 1. Three samples, 92077002, 92077003, and 92077004 had two distinct colored inclusions present in them, as noted in the table. Some material noted by R. Green to be yellow at the time of sample collection had turned green by the time of laboratory receipt.

Qualitative Analyses of Samples

Solubility Testing:

The physical appearance of the samples and cross-reference of lab and field identification are given in Table 1. Results of the solubility test are provided in Table 2.

Based on the appearance of the yellow material found in the samples, tests were performed to see if the material was ferric chloride (6-hydrate), which is a yellow compound. Ferric chloride is soluble in hydrochloric acid, acetone, and methanol. The yellow material from the samples did dissolve in hydrochloric acid, but did not dissolve in acetone or methanol. Therefore, it was concluded that the yellow material in samples 92077001, 92077003, and 92077004 is not ferric chloride. The red materials present in 92077002, 92077003, and 92077004 were soluble in hydrochloric acid, indicating the red powder may be Fe_2O_3 .

Carbonate and Sulfide Qualitative Analyses

Samples were put into test tubes, acid was added and the gas formed was bubbled through a solution of barium hydroxide. Precipitation of barium carbonate compounds in the hydroxide scrubber solution indicate that carbonates are present in the original samples. Results of these tests are presented in Table 3.

Samples 92077003 and 92077004 were the only samples that had substantial effervescence occur when the acid was added. Although carbonate precipitates formed during testing of all four samples, the amount of carbonate species in samples 92077001 and 92077002 is significantly less than that observed in samples 92077003 and 92077004. Samples 92077003 and 92077004 also produced noticeable hydrogen sulfide odor after acidification; the sulfide are likely reduction products of sulfates present in the samples.

Semi-Quantitative Analyses

Water Soluble Anions Determined by Ion Chromatography

One gram of each sample was leached with 10 mL of water for ten minutes and semi-quantitated for water soluble anions by Ion Chromatography, using a one point calibration. The results are shown in Table 4.

Sulfate is present at very high concentrations in the samples, and shows the greatest variation in concentration between samples. Nitrate is also present at higher levels than the remaining anions. Bromide and nitrite were not detected above 2.0 mg/kg in any of the samples.

Analyses for Transition and Toxic Metals

The colored materials from the four samples were selectively weighed for acid digestion (i.e. for samples 92077002, two aliquots, one the green material and the other the red material were separately digested). Five mL of water and 10 mL each of nitric acid and hydrochloric acid were added to each aliquot and the samples were heated and refluxed in the acid solution until no visible color changes occurred and all reactions subsided. Samples were allowed to cool and diluted to a final volume of 100 mL with water. The digestates were analyzed quantitatively by ICP-AES and semi-quantitatively by ICP-MS.

Table 5 presents the quantitative amounts of iron, lead, manganese, copper, chromium, and cadmium determined by ICP-AES. Arsenic was not detected above 100 mg/kg, selenium was not detected above 125 mg/kg, and silver was not detected above 4.0 mg/kg in the samples. High concentrations of iron, chromium, copper, and cadmium are present in some of the samples. Chromium and cadmium levels are high enough in all four samples that it is possible that the samples, as digested (i.e., biased towards the colored inclusions), could be TCLP toxic.

J. R. Zimmerle
April 1, 1992
MCV-03-92
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ICP-MS semi-quantitative analyses supported the concentrations of elements determined by ICP-AES. Table 6 presents semi-quantitative results for other transition and toxic metals not determined by ICP-AES. All eight samples show elevated concentrations of molybdenum. Table 7 shows recoveries for a semi-quantitative standard analyzed by ICP-MS with the samples. Recoveries of this standard indicate the degree of accuracy associated with the semi-quantitative data.

Please contact me or Shelly Sailer at 6-2730 if you have questions concerning these data.

mcv

Attachments:
As stated (7)

cc: J. T. Bennett, MS 4107 *sp for JTB*
R. C. Green, MS 4129
S. J. Sailer, MS 4107 *sp*
Project File - Report Group 920018-A
Central Files - MS 1651
M. C. Verwolf File

Table 1: Physical Descriptions of Samples from TAN Bottle Site

Customer Sample ID	Lab Sample ID	Sample Description
TANBOT92036	92077001	Soil colored orange to yellow
TANBOT92040	92077002	Soil with green & red material present
TANBOT92042	92077003	Light tan soil with small amount of red and yellow material present
TANBOT92044	92077004	Soil with yellow and red material present

Table 2: Observations from Solubility Tests

<u>Sample ID</u>	<u>Solvent</u>	<u>Observation</u>
92077001	Water	No dissolution, yellow-brown tint to solution
	Nitric Acid	Initial small amount of effervescence on yellow material, no dissolution
	HCl Acid	Initial effervescence, some dissolution producing yellow solution
	Sulfuric Acid	Small amount of effervescence, no dissolution
92077002	Water	No dissolution
	Nitric Acid	Small amount of effervescence, no dissolution
	HCl Acid	No effervescence, small amount of dissolution producing yellow solution
	Sulfuric Acid	Very small amount of effervescence, no dissolution
92077003	Water	No dissolution
	Nitric Acid	Small amount of effervescence on yellow material, no dissolution
	HCl Acid	Large amount of effervescence on red material, which dissolved to form yellow solution
	Sulfuric Acid	Very small amount of effervescence, no dissolution
92077004	Water	No dissolution
	Nitric Acid	Small amount of effervescence with yellow material, no dissolution
	HCl Acid	Yellow material did not effervesce, dissolved forming yellow solution; Red material had no effervescence, slower to dissolve than yellow material, formed yellow solution
	Sulfuric Acid	Red material effervesced and the yellow material did not, both red and yellow material were not readily soluble
Ferric Chloride (6 Hydrate)	HCl Acid	Soluble, forms yellow solution
	Acetone	Soluble, forms yellow solution
	Methanol	Soluble, forms yellow solution

Acetone, methanol, and 8 Molar sodium hydroxide were also tested on the samples, all samples had no reaction and no dissolution in these solvents.

Table 3: Qualitative Results for Carbonate Species and Sulfide

Sample ID	Carbonates	Sulfides
92077001	Slight effervescence & small amount of precipitate	No hydrogen sulfide odor
92077002	Slight effervescence & small amount of precipitate	No hydrogen sulfide odor
92077003	Large amount of effervescence & large amount of precipitate	Hydrogen sulfide odor
92077004	Large amount of effervescence & large amount of precipitate	Hydrogen sulfide odor

Table 4: Semi-Quantitative Results for Water-Soluble Anions by Ion Chromatography

Sample ID	mg/kg, wet weight				
	Fluoride	Chloride	Nitrate	Phosphate	Sulfate
92077001	<2.0	<2.0	43	<2.0	14560
92077002	<2.0	5.1	79	2.9	4130
92077003	5.4	5.4	12	<2.0	524
92077004	<2.0	3.9	50	<2.0	3190

Table 5: Results for Quantitative Analysis by ICP-AES

Sample ID	mg/kg, wet weight						
	Fe	Pb	Mn	Cu	Cr	Cd	Ba
92077001 (Yellow)	120900	11	91	1040	950	25	900
92077002 (Green)	5740	55	51	690	800	9.3	860
92077002D (Green)	6090	56	40	715	880	7.2	4060
92077002 (Red)	79600	82	76	2070	5440	15	2420
92077003 (Yellow)	63800	9.9	250	980	3070	100	190
92077003 (Red)	79100	89	300	700	2290	690	1670
92077004 (Yellow)	75000	520	25	240	320	5.4	300
92077004 (Red)	163600	39	260	400	180	53	200

Table 6: Results for Semi-Quantitative Analysis by ICP-MS

Sample ID	mg/kg, wet weight									
	Mg	Al	Ca	V	Ni	Zn	Mo	Hg	Th	U
92077001	4110	10900	50800	48	5.4	34	10300	<3.0	4.4	<3.0
92077002 (Green)	2540	14200	25000	36	<3.0	52	33000	<3.0	5.1	<3.0
92077002D (Green)	1900	12360	22750	23	<3.0	86	33600	<3.0	<3.0	<3.0
92077002 (Red)	1370	4350	37500	15	<3.0	<3.0	55800	<3.0	<3.0	<3.0
92077003 (Yellow)	6730	17900	47300	30	99	<3.0	8310	<3.0	<3.0	<3.0
92077003 (Red)	7460	14100	76500	32	29	50	5410	<3.0	5.1	<3.0
92077004 (Yellow)	540	3300	6110	41	228	<3.0	221400	<3.0	<3.0	<3.0
92077004 (Red)	7820	9410	70100	36	<3.0	<3.0	6200	<3.0	<3.0	<3.0

Table 7: Recoveries for ICP-MS Semi-Quantitative Standard

Element	True Value, ug/L	Found Value, ug/L	% Recovery
Magnesium	100	63.3	63
Aluminum	50	35.9	72
Calcium	50	42.4	85
Vanadium	50	49.1	98
Chromium	50	47.2	84
Manganese	50	57.7	115
Nickel	100	71.2	71
Copper	50	31.8	64
Zinc	50	29.4	58
Barium	50	52.1	104
Uranium	100	90.3	90

ATTACHMENT 2

INTEROFFICE CORRESPONDENCE

Date: December 13, 1993
To: Jerry R. Zimmerle, MS 3952
From: Shannon M. Rood, MS 3960 *SMR*
Subject: TRACK 2-TYPE RISK EVALUATION FOR THE TEST AREA NORTH BOTTLE SITE
(TSF-38) - SMR-32-93

Attached are five copies of the Track 2 type risk evaluation for the Test Area North Bottle Site (TSF-38) earthen mounds area, that you requested. If you have any questions, please feel free to contact me at 526-8927.

td

Attachment:
As Stated

cc: R. L. Nitschke, MS 3960
Central Files, MS 1651
S. M. Rood File

RISK EVALUATION SUMMARY

Test Area North Bottle Site

The TAN Bottle Site (TSF-38) is located approximately 91 m east of the TAN gravel pit. It is comprised of two earthen mounds approximately 18 m long, 1.4 m wide, and 0.3 m high, oriented to the north and south. In May 1991, approximately 15 1-L amber laboratory reagents bottles, five rusted ether cans, and patches of red-stained soil were found lying on the surface in a 1.4 x 2 m area approximately 0.6 m west of the western mound. Soil samples were collected from this smaller area and risk-based soil screening concentrations were calculated using methodology presented in the Track 1 guidance manual¹. Results of this investigation are presented in Reference 2.

Based on the results of this evaluation (i.e., cadmium, chromium, and molybdenum were higher than the risk-based soil screening concentrations), DOE-ID requested an additional risk evaluation be prepared for the two mounds at the site. This evaluation is presented herein.

Source Term

The compounds of concern for this investigation were based on the soil sampling that was conducted in May 1991. No volatile or semi-volatile organic compounds were detected in soil samples collected; therefore, the metals that were detected [i.e., barium, chromium (as both trivalent and hexavalent chromium), copper, lead, molybdenum, nickel, uranium, vanadium, and zinc], plus beryllium and mercury were evaluated. Beryllium and mercury were added based on knowledge of the disposal practices. Other compounds detected at the site for which there are no EPA-approved toxicity information are: iron, thorium, chloride, and sulfate. Although nitrate was detected at the site and there is EPA-approved toxicity data for it, no density information was available to estimate the quantity of nitrates in soil. Therefore, these compounds are not included in this evaluation. Potassium dichromate was also added as a compound of concern because discussions with metallurgists at the INEL^a indicate that it is possible that it was disposed at the site also.

Because the two earthen mounds have not been disturbed the quantity of bottle or the types of reagents/compounds in bottles that are disposed there are unknown. Therefore, it was assumed that one 1-L bottle each of pure compound was disposed. The quantity, in grams, of materials that would have been released to the underlying soil is presented in Table 1. For potassium dichromate, the relative quantity of chromium, in grams, from one 1-L bottle of potassium dichromate was added to the amount (in grams) of chromium in one 1-L bottle. These quantities were then converted to a concentration using a soil density of 1.5 g/cc.

^a Personal Communication between S.M. Rood and R.L. Miller, EG&G Idaho, November 11, 1993.

Table 1. Concentration of compounds per one 1-L bottle.

Compound	Density of Compound (g/cc)	Quantity (g)	Estimated Soil Concentration (mg/kg)
Barium	3.51E+00	3.51E+03	1.06E+01
Beryllium	1.85E+00	1.85E+03	5.61E+00
Cadmium	8.64E+00	8.64E+03	2.62E+01
Trivalent chromium	7.20E+00	7.88E+03	2.39E+01
Hexavalent chromium	7.20E+00	7.88E+03	2.39E+01
Copper	8.92E+00	8.92E+03	2.70E+01
Lead	1.13E+01	1.13E+04	3.42E+01
Manganese	7.20E+00	7.20E+03	2.18E+01
Mercury	1.35E+04	1.35E+07	4.10E+04
Molybdenum	1.02E+01	1.02E+04	3.09E+01
Nickel	8.90E+00	8.90E+03	2.70E+01
Uranium	1.91E+01	1.91E+04	5.77E+01
Vanadium	5.96E+00	5.96E+03	1.81E+01
Zinc	7.14E+00	7.14E+03	2.16E+01

Toxicity Assessment

The calculation of soil screening concentrations is based on a lifetime excess cancer risk of $1\text{E-}06$ due to carcinogenic effects and a hazard quotient of 1 for noncarcinogenic effects. The EPA classifies cadmium as a B1 carcinogen (i.e., probable human carcinogen with limited human data) and chromium-6 as an A carcinogen (i.e., known human carcinogen). The remaining compounds are not classifiable as to human carcinogenicity. Toxicity values are obtained from the EPA on-line database *Integrated Risk Information System* (IRIS)³ and the *Health Effects Assessment Summary Table, Annual Update*⁴. These toxicity values are presented in Table 2. The reference concentration (RfC) for lead is obtained from the National Ambient Air Quality Standards and for this reason the EPA recommends it should not be converted to a reference dose⁴. No credit is taken for chemical degradation in determining the risk-based concentrations for the groundwater pathway in the residential scenario.

Risk-Based Soil Screening Concentrations (backward calculation)

Risk-based soil screening concentrations were determined using methodology presented in the Track 1 guidance manual¹. The exposure scenarios considered are 25 years for an occupational worker at the site in the current time frame and a 30 year resident at the site. Three potential exposure pathways are considered as applicable: soil ingestion, inhalation of fugitive dust, and groundwater ingestion. The equation for the inhalation of fugitive dust for lead was modified to eliminate the body weight and intake rate. Doing this yields a concentration that can be compared to the RfC. For the groundwater pathway, which is considered only for the residential scenario, no time constraints apply; peak groundwater concentrations are used for estimating associated risk-based soil screening concentrations. The site has an areal extent of approximately 220 m^2 with effective dimensions of $18\text{ m} \times 12.2\text{ m}$, and contamination is assumed to be limited to a thickness of 1 m. These dimensions correspond to the area where the earthen mounds are located.

Groundwater transport parameters used for determining the risk-based soil concentration for the groundwater ingestion pathway, given in Tables 3 and 4, are those specified in Reference 1 unless otherwise noted. A conservative estimate for solubility is used. Version 2.01 of the code GWSCREEN⁵ is used for groundwater calculations. For these calculations, aquifer flow is assumed to move in a direction parallel to the long dimension of the site. The sorption coefficient (K_d) values used for modeling transport in the contaminated, unsaturated, and saturated zones are default values from the draft Track 1 guidance manual¹.

The risk-based soil concentrations are presented in Attachment A with the GWSCREEN results presented as Attachment B. The concentrations are given for the exposure pathways considered for both an occupational scenario and a residential scenario.

Table 2. Toxicity values used in risk evaluation.

Contaminant	Oral SF (mg/kg-d) ^a	Oral RfD (mg/kg-d)	Inhalation SF (mg/kg-d) ^a	Inhalation RfD (mg/kg-d)	Inhalation RfC (mg/m ³)
Barium		7.00E-02 ^a		1.40E-04 ^b	
Beryllium	4.3E+00 ^a	5.00E-03 ^a	8.4E+00 ^e		
Cadmium		5.00E-04 ^d	6.3E+00 ^e		
Chromium-3		1.00E+00 ^a			
Chromium-6		5.00E-03 ^a	4.10E+01 ^b		
Copper		1.3 mg/L ^c			
Lead					1.5E-03 ^b
Manganese		5.00E-03 ^f		1.43E-05 ^g	5.00E-05 ^b
Mercury		3.00E-04 ^a		8.57E-05 ^g	3.00E-04 ^b
Molybdenum		5.00E-03 ^a			
Nickel		2.00E-02 ^a			
Uranium		3.00E-03 ^a			
Vanadium		7.00E-03 ^{b, h}			
Zinc		3.00E-01 ^a			

a. Toxicity value obtained from EPA on-line database, IRIS.

b. Toxicity value obtained from EPA, *Health Effects Assessment Summary Tables Annual Update*, PB93-921199, March, 1993.

c. Slope factor calculated from unit risk in IRIS.

d. Toxicity value for ingestion of water. Toxicity value for ingestion of food is 1.0E-03 mg/kg/day. Both values were obtained from IRIS.

e. No toxicity values were available. Used maximum contaminant level for groundwater limiting concentration and was converted to a reference dose.

f. Toxicity value for ingestion of water. Toxicity value for ingestion of food is 1.4E-01 mg/kg/day. Both values were obtained from IRIS.

g. Reference dose calculated from reference concentration in HEAST.

h. Toxicity values is under review.

Table 3. Groundwater transport inputs used for groundwater ingestion risk-based soil concentration calculations (backward calculation).

Aquifer:	
Pore velocity	570 m/y
Longitudinal dispersivity	1E-03 m
Transverse dispersivity	5E-04 m
Length of well screen	15 m
Dry bulk density	1.9 g/mL
Porosity	0.1
Unsaturated zone:	
Net infiltration	1 m/y
Volumetric water content	0.09
Dry bulk density	1.9 g/mL
Depth to groundwater	20 m ^a
Soil zone:	
Soil density	1.5 g/mL
Volumetric water content	0.35
Length of source parallel to flow	18 m
Width of source perpendicular to flow	12.2 m
Thickness of contaminated zone	1 m
Solubility limit	1E+06 mg/L ^b
Receptor distance downgradient	0 m
Receptor distance perpendicular to flow	0 m

a. Depth to groundwater is 61 m in the vicinity of TAN. The depth to groundwater used in GWSCREEN is 1/3 of the depth to groundwater.

b. Solubility limit is used for all contaminants.

Table 4. Compound-specific input factors for GWSCREEN.

Compound	MW	Kd (cm ³ /g)
Barium	1.37E+02	5.00E+01
Beryllium	9.01E+00	2.50E+02
Cadmium	1.12E+02	6.00E+00
Chromium-3	5.20E+01	1.20E+00
Chromium-6	5.20E+01	1.20E+00
Copper	6.36E+01	2.00E+01
Manganese	5.49E+01	5.00E+01
Mercury	2.01E+02	1.00E+02
Molybdenum	9.59E+01	2.00E+01 ^a
Nickel	5.87E+01	1.00E+02
Uranium	2.38E+02	6.00E+00
Vanadium	5.09E+01	1.00E+03
Zinc	6.54E+01	1.60E+01

a. Sorption coefficient obtained from Baes III, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor, *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*, DE-85-000287, September 1984.

The minimum risk-based soil concentration is identified in the second column of Table 5 for comparison to the concentration estimated to be present. The lowest risk-based screening concentration for barium, beryllium, mercury, nickel, and vanadium is from soil ingestion. For lead, it's inhalation of fugitive dust, and the remaining compounds is ingestion of groundwater. The time to the peak groundwater concentrations range from 48 years for both trivalent and hexavalent chromium to approximately 9,600 years for beryllium. These risk-based soil screening concentrations were compared to the estimated concentrations of each compound. Estimated concentrations of beryllium and mercury exceed these risk-based soil screening concentrations.

Limited Sensitivity Analysis

Because the actual area of contamination at the earthen mounds is not known, a limited sensitivity analysis was performed to evaluate the effects of size of the site to the risk-based soil screening concentrations. Risk-based soil screening concentrations were determined for three sites: the base case with dimensions of 18 x 12.2 x 1 m and two other sites, one being 9 x 6 x 1 m (one quarter size of the original area) and the other 9 x 6 x 0.5 m (one-eighth the size of the original area). Concentrations of the compounds in the smallest area (i.e., the highest concentration), along with the minimum risk-based soil screening concentrations for all sites are presented in Table 5. Comparison of these values indicate that cadmium also exceeds the risk-based soil screening concentrations in both of the smaller areas. The complete results of these calculations are presented as Attachment A. GWSCREEN results are presented as Attachment B.

Typically, as the size of the area gets smaller, the greater the risk-based soil concentration for the groundwater ingestion and inhalation of fugitive dust pathways. Therefore, as the site gets smaller, the risk-based soil concentration for the soil ingestion pathway becomes the limiting concentration. Comparing the estimated concentrations of the compounds from the smallest site to the risk-based soil concentrations for the soil ingestion pathway, mercury is the only compound where the estimated concentration exceeds the risk-based soil concentration for the ingestion pathway (Attachment A).

Risk Assessment (forward calculation)

Conservative assumptions are used in a Track 1 risk evaluation to determine concentrations of compounds in soil that would not pose adverse effects to human health (i.e., risk-based soil concentrations). Because the estimated concentrations for beryllium, cadmium, and mercury exceed these risk-based soil concentrations, a Track 2 risk assessment is performed to estimate the incremental cancer risk and hazard quotient posed by the estimated concentrations for each of the compounds of concern. For this risk assessment, methodology contained in the Track 2 guidance manual⁶ is used. The exposure assessment is for two scenarios:

Table 5. Comparison of minimum RBCs^a to estimated soil concentrations.

Compound	Estimated Concentration Full site (mg/kg)	Minimum RBC Full site (mg/kg)	Estimated Concentration 1/4 site (mg/kg)	Minimum RBC 1/4 site (mg/kg)	Estimated Concentration 1/8 site (mg/kg)	Minimum RBC 1/8 site (mg/kg)
Barium	1.06E+01	1.89E+04	4.33E+01	1.89E+04	8.67E+01	1.89E+04
Beryllium	5.61E+00	1.49E-01	2.28E+01	1.49E-01	4.57E+01	1.49E-01
Cadmium	2.62E+01	3.67E+01	1.07E+02	7.31E+01	2.13E+02	1.40E+02
Trivalent chromium	2.39E+01	7.19E+04	9.73+01	1.38E+05	1.95E+02	2.70E+05
Hexavalent chromium	2.39E+01	3.59E+02	9.73E+01	6.92E+02	1.95E+02	1.34E+03
Copper	2.70E+01	4.19E+03	1.10E+02	8.13E+03	2.20E+02	1.17E+04
Lead	3.33E-09 ^b	5.03E+06 ^b	1.48E-11 ^b	1.01E+07 ^b	1.48E-11 ^b	1.01E+07 ^b
Manganese	7.20E+00	1.36E+03	8.89E+01	2.39E+03	1.78E+02	2.81E+03
Mercury	1.35E+04	8.10E+01	1.67E+05	8.10E+01	3.34E+05	8.10E+01
Molybdenum	1.02E+01	5.96E+02	1.26E+02	1.16E+03	2.52E+02	1.35E+03
Nickel	8.90E+00	5.40E+03	1.10E+02	5.40E+03	2.20E+02	5.40E+03
Uranium	1.91E+01	2.20E+02	2.35E+02	4.39E+02	4.70E+02	8.10E+02
Vanadium	5.96E+00	1.89E+03	7.36E+01	1.89E+03	1.47E+02	1.89E+03
Zinc	7.14E+00	3.12E+04	8.81E+01	6.09E+04	1.76E+02	8.10E+04

a. RBC = risk-based soil concentration

b. Concentrations for lead are presented in mg/m³.

- an occupational worker exposed to the site for 25 years in the current time frame
- a resident who moves to the site 30 years in the future and digs a 10-ft basement

For each scenario, two potential exposure pathways are evaluated: soil ingestion, and inhalation of fugitive dust. Groundwater ingestion was only evaluated for the residential scenario. No time constraints apply to this pathway; groundwater concentrations are used for assessing risk for the 30-year time period in which the peak occurs. Both the occupational and residential scenarios use standard exposure factors⁷.

The GWSCREEN code, Version 2.01 was used for all groundwater calculations; output is presented as Attachment C. Groundwater transport parameters, used as inputs to the model and specified in the draft Track 2 guidance manual, along with other site-specific dimensions used in the exposure calculations are listed in Table 6. Sorption coefficients and molecular weights are presented in Table 4. The area of contamination used in the risk assessment was the smallest area (i.e., 1/8 size) because it has the highest estimated soil concentrations. The concentrations presented in Table 5 are used for all compounds with the exception of lead. The EPA clean-up criteria for lead ranges from 500 - 1,000 mg/kg⁸, which is higher than the estimated 279 mg/kg. Therefore, a concentration of 1,000 mg/kg was used.

Table 7 shows the results of risk calculations based on the estimated concentrations of the compounds. The hazard quotients shown in this table are the ratio of chronic daily intake to the noncarcinogenic reference dose for a given compound. Therefore, a hazard quotient greater than one indicates an exposure to the compound that is greater than the reference dose. Risk values are the incremental risk posed by the compound and are the product of the chronic daily intake and the compound's slope factor.

The total risk for the occupational scenario is 3E-05 and represents the potential incremental risk posed by ingesting soil contaminated with beryllium. The second largest risk driver is chromium-6 (9E-08) for the inhalation pathway. The total hazard quotient (HQ) for noncarcinogenic effects is 5E+02. Mercury has the largest hazard quotient (5E+02) and it's for the soil ingestion pathway. The next largest HQ is for soil ingestion of cadmium (1E-01). The next largest risk drivers for the occupational scenario are below levels that indicate a potential adverse health effect.

The total risk for the residential scenario is 3E-04 and represents the potential incremental risk posed by ingesting soil contaminated with beryllium. The second largest risk driver is chromium-6 (3E-08) for the inhalation pathway. The total HQ for noncarcinogenic effects is 4E+03 which constitutes the hazard quotient for ingestion of soil contaminated with mercury. The next largest HQ is for soil ingestion of cadmium (8E-01). The next largest risk drivers for the occupational scenario are below levels that indicate a potential adverse health effect.

Table 6. Groundwater transport inputs used for groundwater ingestion calculations (forward calculation).

Aquifer:	
Pore velocity	570 m/y
Longitudinal dispersivity	9 m
Transverse dispersivity	4 m
Length of well screen	15 m
Dry bulk density	1.9 g/mL
Porosity	0.1
Unsaturated zone:	
Net infiltration	0.1 m/y
Volumetric water content	0.3
Dry bulk density	1.9 g/mL
Depth to groundwater	6.1 m ^a
Soil zone:	
Soil density	1.5 g/mL
Volumetric water content	0.3
Length of source parallel to flow	9 m
Width of source perpendicular to flow	6 m
Thickness of contaminated zone	0.5 m
Solubility limit	1E+06 mg/L ^b
Receptor distance downgradient	4.5 m
Receptor distance perpendicular to flow	0 m

a. Depth to groundwater is 61 m in the vicinity of TAN. The depth to groundwater used in GWSCREEN is 1/10 of the depth to groundwater.

b. Solubility limit is used for all contaminants.

Table 7. Risk Assessment Summary Table
OU: 1-03 [TSF-38 Earthen Mounds (1/8 site)]

Site: TSF-38 Bottle Site

		Occupational Scenario												
		Site: TSF-38 home site												
		Site: TSF-38 Earthen Mound (1/8 site)												
Contaminant	Estimated Concentration (mg/kg)	Soil Ingestion		Inhalation of Dust		Inhalation of Volatiles		External Exposure		Groundwater Ingestion		Total Other Than Groundwater Ingestion		
		HQ	Cancer Risk	Cancer Risk from Radionuclides	HQ	Cancer Risk	Cancer Risk from Radionuclides	HQ	Cancer Risk	Cancer Risk	HQ	Cancer Risk	HQ	Cancer Risk
Barium	8.67E+01	6E-04	NA	NA	2E-05	NA	NA	NA	NA	NA	NA	NA	6E-04	NA
Beryllium	4.57E+01	4E-03	3E-05	NA	NA	4E-09	NA	NA	NA	NA	NA	NA	4E-03	3E-05
Cadmium	2.13E+02	1E-01	NA	NA	NA	1E-08	NA	NA	NA	NA	NA	NA	1E-01	1E-08
Chromium-3	1.95E+02	1E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1E-04	NA
Chromium-6	1.95E+02	2E-02	NA	NA	NA	9E-08	NA	NA	NA	NA	NA	NA	2E-02	9E-08
Copper	2.20E+02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	1.00E+03	NA	NA	NA	7E-05	NA	NA	NA	NA	NA	NA	NA	7E-05	NA
Manganese	1.78E+02	6E-04	NA	NA	4E-04	NA	NA	NA	NA	NA	NA	NA	1E-03	NA
Mercury	3.34E+05	5E+02	NA	NA	1E-01	NA	NA	NA	NA	NA	NA	NA	5E+02	NA
Molybdenum	2.52E+02	2E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2E-02	NA
Nickel	2.20E+02	5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5E-03	NA
Uranium	4.70E+02	8E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8E-02	NA
Vanadium	1.47E+02	1E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1E-02	NA
Zinc	1.76E+02	3E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3E-04	NA
Total		5E+02	3E-05		1E-01	1E-07							5E+02	3E-05

Table 7 (continued)

OU: 1-03 [TSF-38 Earthen Mounds (1/8 site)]

Site: TSF-38 Bottle Site

Residential Intrusion Scenario

Contaminant	Soil Ingestion			Inhalation of Dust			Inhalation of Volatiles		External Exposure	Groundwater Ingestion		Total Other Than Groundwater Ingestion	
	HQ	Cancer Risk	Cancer Risk from Radionuclides	HQ	Cancer Risk	Cancer Risk from Radionuclides	HQ	Cancer Risk	Cancer Risk	HQ	Cancer Risk from Radionuclides	HQ	Cancer Risk
Barium	5E-03	NA	NA	3E-05	NA	NA	NA	NA	NA	6E-06	NA	5E-03	NA
Beryllium	3E-02	3E-04	NA	NA	7E-09	NA	NA	NA	NA	7E-06	1E-11	3E-02	3E-04
Cadmium	8E-01	NA	NA	NA	5E-09	NA	NA	NA	NA	1E-02	NA	8E-01	5E-09
Chromium-3	7E-04	NA	NA	NA	NA	NA	NA	NA	NA	1E-05	NA	7E-04	NA
Chromium-6	1E-01	NA	NA	NA	3E-08	NA	NA	NA	NA	2E-03	NA	1E-01	3E-08
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA	6E-05	NA	NA	NA
Lead	NA	NA	NA	9E-06	NA	NA	NA	NA	NA	1E-04	NA	9E-06	NA
Manganese	5E-03	NA	NA	3E-04	NA	NA	NA	NA	NA	NA	NA	5E-03	NA
Mercury	4E+03	NA	NA	4E-05	NA	NA	NA	NA	NA	2E+00	NA	4E+03	NA
Molybdenum	2E-01	NA	NA	NA	NA	NA	NA	NA	NA	5E-04	NA	2E-01	NA
Nickel	4E-02	NA	NA	NA	NA	NA	NA	NA	NA	2E-05	NA	4E-02	NA
Uranium	6E-01	NA	NA	NA	NA	NA	NA	NA	NA	4E-03	NA	6E-01	NA
Vanadium	8E-02	NA	NA	NA	NA	NA	NA	NA	NA	4E-06	NA	8E-02	NA
Zinc	2E-03	NA	NA	NA	NA	NA	NA	NA	NA	7E-06	NA	2E-03	NA
Total	4E+03	3E-04		3E-04	5E-08					2E+00	1E-11	4E+03	3E-04

Uncertainty

A major point of uncertainty with this risk evaluation is that the quantity of and the actual compounds disposed in the area of the mounds is not known. Estimates of concentrations for several metals are based on one 1-L bottle of pure compound being disposed. A decrease in half of the size of the area of contamination would result in a doubling of the concentration of the compounds.

From the soil samples collected from the smaller area west of the earthen mounds, three compounds (i.e., cadmium, chromium, and molybdenum) were detected at concentrations higher than the concentrations estimated based on one 1-L bottle of pure compound. Using the concentrations detected in the soil samples for these compounds indicates that all three compounds would pose a hazard to human health.

Two of the risk drivers at this site are beryllium and mercury. Neither of these compounds were detected in soil samples collected from the area just west of the earthen mounds, therefore it is unlikely that they are present at the mounds. In addition, the minimum risk-based soil concentrations for beryllium (0.149 mg/kg) is less than the 90th percentile of the background value (1.5 mg/kg)⁶. Both these factors bias the potential for adverse health effects high.

The exposure assessment has uncertainty in groundwater contaminant transport calculations because these calculations use conservative input parameters. For example, a high solubility (1E+06 mg/L) is used for all contaminants, so leaching of contaminants from the source volume is not limited by solubility. Similarly, the sorption coefficients used in the transport modeling are conservatively low to allow for the maximum amount of compound to be available for transport. These conservative assumptions cause the groundwater ingestion risk calculations to be biased high. Irrespective of input values, GWSCREEN provides bounding estimates of impacts on groundwater rather than best estimates. In addition, it is assumed that all of a given compound is available for release for each pathway. This biases the potential for adverse health effects high.

Toxicity data was not available for both the ingestion and inhalation pathways for all the compounds. This may bias the results low because analysis of pathways for some compounds could not be performed.

Uncertainty in the risk characterization step occurs because slope factors are estimates of percentiles in the upper tails of the distribution and additions of such percentiles overestimate the same percentile for the sum. Also, summing of hazard quotients for noncarcinogenic gives equal weight to critical effects of varying toxicological significance (i.e., effects may be manifested in different target organs) and may not be appropriate.

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